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Migration patterns of juvenile winter-run size Chinook salmon (*Oncorhynchus tshawytscha*) through the Sacramento – San Joaquin Delta

Abstract: The decline of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) remains one of the major water management issues in the Sacramento River. Few field studies have been published on winter-run, leaving gaps in our knowledge about their life history. This is especially true in the Sacramento-San Joaquin Delta, which provides essential rearing and migratory habitats for winter-run, and serves as the center of water operations for California. Using long-term monitoring data that identified winter-run using length-at-date criteria, we examined patterns of juvenile migration through the Delta in terms of geographic distribution, timing, numbers, and residence times. We analyzed the role of flow, turbidity, temperature, and adult escapement on migration patterns. Winter-run passed Knights Landing (at RKM 144 or 51 RKM upstream of the Delta) between November and January, with substantial variation in time of entry. The start of winter-run migration past Knights Landing was strongly associated with the first high flows of the migration season. Specifically, the first day of flows of at least $400 \text{ m}^3 \text{ s}^{-1}$ at Wilkins Slough (at 190 RKM) coincided with the first day that at least five percent of the annual total catch was observed at Knights Landing. While the period during which smolts left the Delta spanned several months based on Chipps Island catch data, the median catch occurred over a narrow window typically in March. Differences in timing of cumulative catch at Knights Landing and Chipps Island indicate that apparent residence time in the Delta ranges from 41-106 days, with residence time being longer for juveniles arriving earlier in the Delta. We discuss the importance of the Yolo Bypass floodplain as an alternative rearing and migratory corridor, which likely depends on the timing, duration, and magnitude of floodplain inundation. These results carry management implications for habitat restoration and management of Sacramento River flows.

Statement of Relevance: Our study identified patterns in timing and duration of winter-run emigration that inform Bay Delta Conservation Plan's water operations and Yolo Bypass management. Specifically, study results guide development of early winter flow protection for juveniles, and patterns of Delta and Yolo Bypass residence can inform future floodplain and water management.

Statement of Relevance: At the present time, there is no mechanism for storing, analyzing, or retrieving Central Valley juvenile Chinook salmon data in a timely, consistent manner. The CAMP's RST system will resolve these issues, and provide data to assess population trends and make inferences about the biological response to habitat restoration activities.